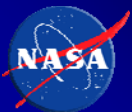


# Revolutionary Space Exploration Concepts Using Onboard Computing:

## Mars Odyssey and Mars Rovers Applications

Rebecca Castano  
Jet Propulsion Laboratory  
Caltech Institute of Technology

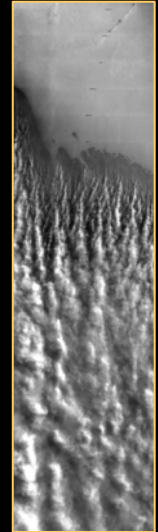
May 25, 2006



# Overview

- Objectives:
  - Identify and respond to science opportunities
  - Prioritize data onboard for transmission based on data features
- Applications
  - THEMIS event detection
  - MER Atmospheric event detection

THEMIS  
image



NASA/JPL/Arizona  
State University



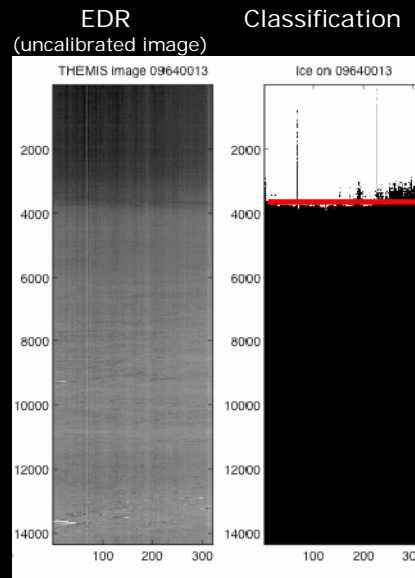
NASA/JPL/Texas A&M

# Onboard Data Mining for THEMIS/Odyssey

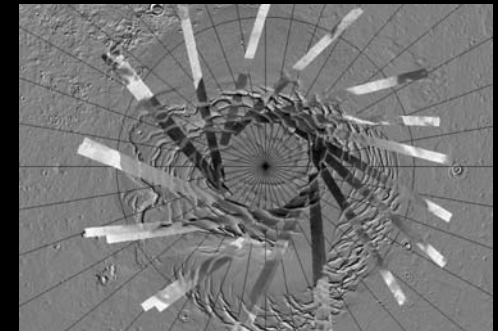


Courtesy NASA/JPL-Caltech

We can increase spatial and temporal coverage of searching for specific features of interest by analyzing the data onboard



Cap  
edge  
Latitude =  
59.6



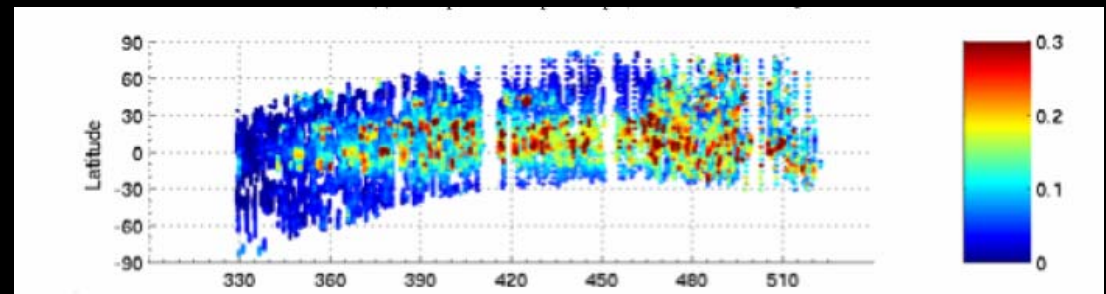
Mars, North Pole, THEMIS  
orbits 4319-4399  
(northern summer)

JMARS - Noel Gorelick, ASU

NASA/JPL/Arizona State University

## Selected science features

- Thermal anomalies
- Polar volatiles
- Dust storms
- Water ice clouds



Estimated water-ice cloud optical depth for  $L_s=330$  to  $L_s=161$  (wrapped)

# Dynamic Event Detection: Dust Devils and Clouds

Cloud and dust devil campaigns are conducted regularly on MER. These phenomena occur year-round, but generally are rare.

Onboard detection and selection of images containing these phenomena has the potential to greatly improve atmospheric science campaigns.

Algorithms have been fully tested and integrated into MER flight software and are ready for upload in early summer 2006.

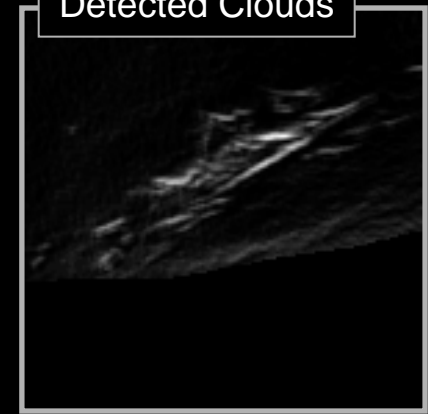


Courtesy NASA/JPL-Caltech

Original



Detected Clouds



Detected Dust Devils



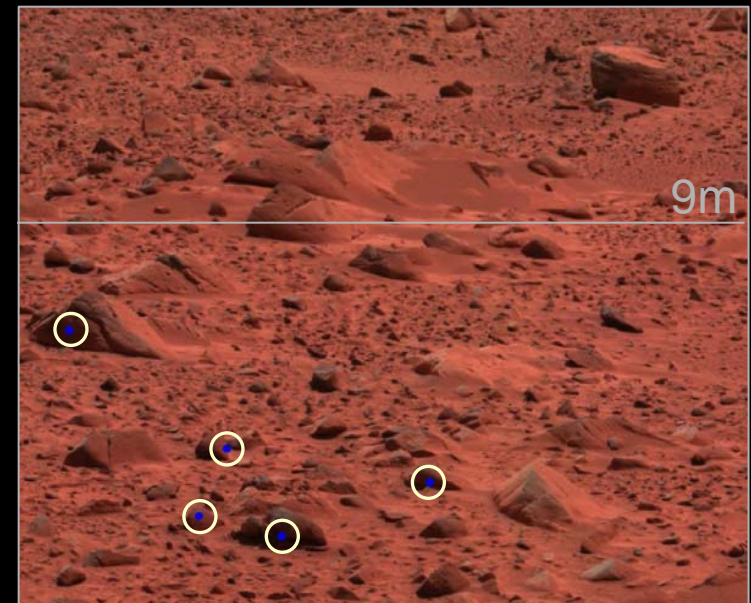
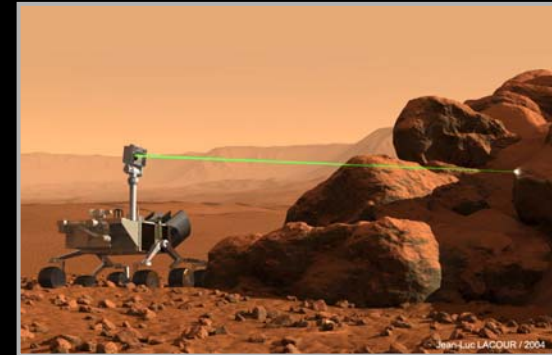
# End-of-sol Science: Automated Target Selection

Very narrow field-of-view instruments  
require selection of specific targets for  
sampling (E.g. ChemCam on Mars  
Science Laboratory rover)

Onboard automated target selection can  
greatly increase the samples of targets  
of interest

With typical 10% rock coverage

- Random (blind) sampling
  - Expected only 1 out of 10 samples will be of a rock
- 90% target success rate
  - Expected 9 out of 10 samples will be of a rock
  - 9X increase in science return over blind sampling



Spirit Rover – Legacy site  
Portion of panorama taken with PanCam

Cornell/NASA/JPL

Selected targets are shown in blue



# Traverse/Opportunistic Science

Due to limited downlink bandwidth and increased driving distances, rovers will not be able to transmit detailed imagery for all portions of long traverse paths

Onboard science data analysis can increase the science return from a rover traverse by identifying science features during the traverse

The Onboard Autonomous Science Investigation System (OASIS) enables identification and reaction to serendipitous science opportunities during a traverse.

Capabilities include

- Identify pre-specified targets of interest
- Detect unusual/novel signatures
- Data summarization
- Collect additional data



This technology has been tested on a field test rover in addition to simulation

Meteorite encountered by Opportunity rover



Cornell/ NASA/JPL

Petrified wood identified by OASIS as novel (image from field test near Flagstaff, AZ)



FIDO NASA/JPL